A
000 081 386
5
UC SOUTHERN REGIONAL LIBRARY FACILITY

THE

NATIONAL

ENCYCLOPÆDIA:

A

DICTIONARY OF

UNIVERSAL KNOWLEDGE

BY WRITERS OF EMINENCE IN LITERATURE, SCIENCE, AND ART.

VOL. X.

PEEBLESSHIRE——ROOTS.

LONDON:

WILLIAM MACKENZIE, 22 PATERNOSTER ROW;

HOWARD STREET, GLASGOW; SOUTH BRIDGE, EDINBURGH.

Annex
5012772

island imports about half its requirements from England, and exports more than half of its products to the United States. Shipbuilding is an important branch of industry. In the year 1863, 100 vessels of the aggregate burthen of 24,991 tons were built; the value of which was 125,000*l.*; but in 1865 the number was only fifty-seven, of 13,000 tons burthen in all.

The island, which is well traversed by good roads, is divided into three counties—King's, Queen's, and Prince's County. The chief places are Charlotte Town, George Town, and Prince Town. *Charlotte Town*, the capital and seat of government, in Queen's County, is situated on the north side of Hillsborough River, near its confluence with the rivers Elliot and York. It is on the south coast of the island, and has a good harbour, which, indeed, is considered one of the best in the Gulf of St. Lawrence. The town stands on gently rising ground, and is regularly built, with broad streets intersecting each other at right angles. Its principal buildings are—the Episcopal and Scotch churches, the chapels, the court-house, the barracks, the fort, and the Prince of Wales' College, founded in 1860, the principal educational establishment in the island. The population in 1861 was 6706. Shipbuilding employs a large number, and in the town are also an iron foundry, and a coarse woollen factory. *Prince Town*, the capital of Prince's County, is on the N. coast, 35 miles to the N.W. of Charlotte Town.

Prince Edward Island was discovered by Cabot in 1497. It was taken possession of by the French after the settlement of Canada. In 1758 it was taken by the English, and has ever since belonged to Great Britain. It was separated from Cape Breton and constituted an independent colony in 1768. In 1856 free schools were established all over the island, which are supported by a tax on land, producing between 4000*l.* and 5000*l.* per annum—imposed by the local legislature. The English law is administered by a chief justice, and there are district courts for the recovery of small debts.

PRINCE OF WALES' ISLAND. [PENANG.]

PRINCE WILLIAM'S SOUND is a wide bay on the N.W. coast of North America, extending, with several branches, between 60° and 61° N. lat., and between 146° and 148° 30′ W. long. It opens to the south, and the entrance contains two large islands, of which the eastern is called Rose Island, and the western Montague Island. There are no good harbours; Rose Island contains Port Etches, where the Russians have a factory, and a wooden fort, called Fort Constantine. The islands are rocky and mountainous. The country contains pine, alder, and hazel trees, and strawberries, raspberries, and alderberries. Sea-otters and foxes are met with, and other fur-bearing animals are abundant in the forests. The natives, who are few in number, and called Oogaliakhmntes, live mostly on the produce of their fishing. They seem to be a cross between the Esquimaux and the other Indians.

PRINCE'S METAL, or *Prince Rupert's Metal*, an alloy of copper and zinc, which contains more copper than brass does, and is prepared by adding this metal to the alloy.

PRINCETON. [NEW JERSEY.]

PRINCIPATO ULTRA or AVELLINO, is a province of the kingdom of Italy (formerly of Naples), in the S., having an area of 1288 square miles. The surface is very mountainous, but includes numerous fertile valleys, which are watered by the rivers Volturno and Sele, and their affluents. The vegetation is most luxuriant.

Owing to the local situation of the province and its elevation above the sea, the temperature is considerably lower upon the whole than that of the plains of Campania, although in some of the valleys the summer heats are occasionally very great. Some places in the valley of the Calore (an affluent of the Volturno), are subject to the malaria in consequence of stagnant waters. The country produces corn, fruits in abundance, silk, some wine, and excellent pasture for cattle, large numbers of which are reared. The population of the province in 1862 was 355,621. The principal towns are AVELLINO; ARIANO; *Montesarchio*, 13 miles N.W. from Avellino, with about 6000 inhabitants; *Montefusco*, with 3000; and *Sant' Angelo-dei-Lombardi*, with more than 6000 inhabitants.

PRINTING is the one of all the arts which has done most for the happiness and prosperity of the human race. It lies at the bottom of that refined and comprehensive civilization on which the Western races not unjustly pride themselves. Had it not been invented, they would never have attained to their present standard of intellectual development, or even of material well-being. Thought must have been limited in its circulation; opinion restricted to a narrow circle of influence. The minds of men could never have interchanged ideas with that fulness and facility which are so essential to the diffusion of truth. Probably long ere this the manuscript literature of Greece and Rome might have perished, and modern intellect have lost one of its greatest inspirations. The spread of the doctrines of Luther and the Reformers must have been seriously checked, if not wholly prevented, had not the press come to their aid, to multiply copies of the Bible at a rate and a cost which brought the Word of Truth within the reach of all classes. Neither the poet nor the philosopher, the historian nor the divine, could have made a permanent impress on the spirit of his age. Learning must have remained the exclusive privilege of the Few, and the Many must still have languished in comparative thraldom and obscurity. That new power which exercises so subtle an effect on the polity of nations and the proceedings of governments—which, if sometimes mistaken, is usually on the side of Right, and proves an invaluable support to the wise legislator and the sagacious humanitarian—is the direct offspring of the Printing-press. In a word, if the reader compares the nineteenth century with the fifteenth, he will obtain at a glance a correct conception of the deep and eternal debt of gratitude which he and all men owe to the inventor of this noble art.

It is no marvel, therefore, that the question, Who *was* the inventor? has been the subject of continual discussion. It may seem strange that any doubt should prevail in reference to a point like this. One would suppose that the name of so great a benefactor to humanity would be as certainly and as widely known as that of the victor of Marathon, or the conqueror at Cannæ. With most great inventions, however, a similar difficulty exists. They would appear to be, not the unaided effort of the labour and ingenuity of one active mind, but the accumulated results of *many* minds contemporaneously but independently working towards one end. These results are finally embodied in a practical form by some fortunate genius, whom posterity is generally content to reward with the glory that should be shared among his predecessors. Earl Russell has felicitously defined a proverb as 'the wisdom of many and the wit of one.' A great invention, in like manner, may be described as the thought of many and the work of one. Watt invented

1292331

the steam-engine; that is, he made practicable the ideas of Savary, Denis Papin, and Newcomen. Gutemberg invented printing; that is, he carried out the cruder ingenuity of Laurence Koster and others.

The invention of printing took place early in the fifteenth century; but the principles on which it was founded were known to the fathers of civilization, the ancient Assyrians. Among the ruins of Babylon have been discovered entire bricks stamped with symbolic figures and hieroglyphical characters. It should be observed, however, that in this, as in all similar relics of antiquity, the figures were impressed by one block or piece, which was only available for a single subject. It was, in fact, rather *engraving* than printing, and is still practised by the Chinese, who print from the block, and consequently require a separate block for every page, the block being perfectly useless for any other purpose. A similar mode of printing playing-cards and rude Scriptural illustrations was in vogue in Europe about the middle of the fourteenth century. It is evident, however, that printing, in this fashion, and of this limited kind, could never have been made available in any extensive degree for the diffusion of knowledge. The great discovery in printing, which rendered it so important an agency in the work of civilization, was that of *movable types;* of forming each alphabetical character *separately,* so that it could be used in countless combinations, the same types being employed in 'setting up' successive pages. It was this discovery which rendered *cheap books* possible. Previously, their enormous cost had entirely confined them to the libraries of the wealthy. In 1272 the pay of a labourer was 1½*d.* per day. At that time the price of a Bible, 'fairly written,' was fifty marks, or 33*l.*, a sum equal to 660*l.* at the present value of money. At a later period, the price of a single book of Livy was 120 crowns of gold; and the folio MS. of the 'Romans de la Rose' cost forty crowns, or about 33*l.* 10*s.* sterling.

About 1438 one Laurenzio John Koster, of Haarlem, printed with blocks a book of images and letters, called 'Speculum Humanæ Salvationis,' for which he employed an ink more tenacious and viscous than common ink. The leaves of this book were printed on one side only, and afterwards pasted together.

A few years afterwards, John Gutemberg, or Guttenburg, of Mentz, entered into partnership with an opulent goldsmith named John Fust or Faust, and, after numerous experiments, printed the first book from *cut*, or movable, metal types; namely, an edition of the Vulgate Bible, which was begun about 1450 and completed in 1460.

In 1452 Peter Schœffer, son-in-law of Fust, cast the first metal types in matrices, and was therefore the actual inventor of complete printing. Cast-metal types, according to some authorities, were first used for a second edition of the Mentz Bible.

These were the principia, the beginnings, of the art. The partnership between Gutemberg and Fust was soon dissolved; and the former being unable to repay part of the capital advanced by the latter, the whole of the printing apparatus fell into the hands of Fust, who printed off a considerable number of copies of the Bible, to imitate those which were commonly sold as MSS., and undertook the sale of them at Paris. It was his interest to conceal this discovery, and to pass off his printed copies for MSS. 'But,' says D'Israeli, 'enabled to sell his Bibles at sixty crowns, while the other scribes demanded 500, this raised universal astonishment; and still more when he produced copies as fast as they were wanted, and even lowered his price. The uniformity of the copies increased the wonder. He was denounced as a magician. The peculiarly brilliant red ink which embellished his work was said to be his blood; and it was seriously asserted that he had sold himself to the Evil One. Fust, to save himself from a bonfire, was compelled to reveal his art to the Parliament of Paris, by whom he was discharged from further prosecution, in consideration of the wonderful nature of his invention.'

Fust now took into partnership his son-in-law Schœffer, and the two commenced printing from cast-metal types. In 1459 they issued an edition of the Psalter; and in this, says Hallam, the invention was announced to the world in a boasting colophon, though certainly not unreasonably bold. In 1465 they published an edition of Cicero 'De Officiis,' the first tribute of the new art to polite literature. Two pupils of their school, Sweynheym and Pannartz, migrated the same year into Italy, and printed Donatus' grammar and the works of Lactantius at the monastery of Subiaca, in the neighbourhood of Rome. Venice had the honour of bestowing her patronage on John of Spira, the first who applied the art on an extensive scale to the publication of classical writers. Several Latin authors came forth from his press in 1470; and during the next ten years a multitude of editions were published in various parts of Italy, Germany, and France. The art reached Paris in 1469, England in 1474, and Spain in 1475. Its introduction was coeval with a remarkable intellectual movement in Europe. The days of feudalism had passed. Through all Christendom the old order was dying out, and men were eagerly watching for the dawn of a great revolution. The ground was athirst, and readily drank up the blessed waters that flowed from fountains so opportunely opened. Santander, in his elaborate 'Dictionnaire Bibliographique,' supplies a list of 200 places where printing was already practised before the close of the fifteenth century, with the names of the printers and the first productions of their presses.

The types first employed were all in the Gothic or Old German (now known as the 'black letter') character, and Greek was not used until 1465, in an edition of Cicero's 'Offices,' where it is so imperfect as to be scarcely decipherable. The first book wholly printed with Greek types was a Greek grammar written by the learned Constantine Lascaris, and issued at Milan by Dionysius Paravisinus, in 1476. A far finer specimen of typography, however, was the first edition (1500) of the 'Argonautica.' The first Greek book printed at Cambridge was Plato's 'Menexenus,' in 1515. The first book in which the Roman type was used was Cicero's 'Epistolæ ad Familiares,' not inappropriately printed at Rome (1467), by Sweynheym and Pannartz. Aldus Manutius invented *Italic type* at Venice, about 1500. Hebrew characters were introduced at Soncino, in the Milanese, in 1488, by two Jewish rabbi, named Joshua and Moses, who issued a Hebrew version of the Old Testament. Towards the close of the sixteenth century various Oriental types were introduced by active and enterprizing printers.

The father of the English printers was the ingenious William Caxton, who, in or about the year 1471, established a printing-press near the Sanctuary, Westminster, in an old chapel of the famous abbey. There, having learned the art abroad, he was occupied for many years as a printer, and also as an author, translating and editing books on a great variety of topics. Sixty-four works, in all, are said to have issued from his press. He employed Gothic characters, mixed with a kind of written hand; and instead of commas or periods, an

oblique stroke, thus / . He used no signatures, and never numbered his pages. His device consisted of W. C. and 74, the year in which he introduced his art into England. [CAXTON.]

His pupils and followers were John Letton, Theodore Rood, William Machiliana, and Wynkyn de Worde, foreigners, and Thomas Hunt, an Englishman. Wynkyn de Worde was the first printer in England who made use of the Roman letter. All his works, and they number 410, are distinguished by their typographical excellence.

For the first sixty or seventy years all copies of the Scriptures reproduced by the new art were printed in Latin or Greek. The first English version *printed* was that of Tindal and Coverdale; it appeared at Antwerp, in 1526, but the whole impression was bought up and burnt by Cardinal Wolsey's orders. The first complete English translation printed by authority, was Tindal's version, corrected by Coverdale, and examined by Archbishop Cranmer. It was called Cranmer's Bible, and printed by Grafton and Whitchurch, 1539–44.

It is a remarkable characteristic of the English printers that, while their continental brethren in the art were confining their efforts to the reproduction of the ancient classics, they issued works in their own native tongue, and so contributed to its development and perfection. They were chiefly patronized by the English nobles, who eagerly bought their versions of ancient authors, of devout books, French and Italian romances, and mediæval chronicles. A list of the works printed in England between 1550 and 1600 would throw a vivid and interesting light on the tastes and intellectual tendencies of the English higher classes. The love of knowledge soon spread to the commonalty, and a great demand arose for educational works, for chronicles, romances, and ballads, and for the writings of native poets, so that no less than 350 printers flourished during the sixteenth century in England and Scotland, who, in the same period, published between 8000 and 9000 distinct works.

The Civil War temporarily checked the progress of the art, nor was the licentious reign of Charles II. calculated to favour its growth. An Act of Parliament actually existed which limited the number of printers to twenty-nine, and these were hampered with severe legal restrictions, and compelled to obtain the licenser's authority before they could issue the most trivial broadsheet. Literature, consequently, was almost wholly confined to the metropolis or its immediate neighbourhood. Only such flimsy works as could be carried by the post-boy reached country divines and country justices. Provincial printing presses were 'conspicuous by their absence.' The parsonage was scantily furnished with books, and the houses of the gentry could scarcely boast of a much better supply. The whole number of books printed between 1666 and 1680 was only 3550, or at an annual average of 253. If we deduct from these reprints, sermons, pamphlets, and maps, we may conclude that the yearly product of new works did not exceed eighty.

The great French Revolution which, towards the close of the eighteenth century, lent so extraordinary an impulse to Thought upon the Continent, extended its quickening and enlivening influences to the British Isles. One of its consequences was a remarkable increase in the number of new books issued annually. There were more men with something to say than in less active times, and more men willing and anxious to hear. In fact, popular literature dates from this epoch. We hear no more of the rich or titled patron. Authors had learned to address themselves to the public, and obtained from the public a surer and more liberal reward than from even such enlightened judges as Dorset or Halifax. From 1792 to 1802, or in a period of eleven years, 4096 new works were published, exclusive of pamphlets, and, of course, of reprints. These figures give a yearly average of 372, or four times the previous yearly amount. From this time there was no let or hindrance in the onward course of the Printer. He soon became the agent of the political news-gatherer, and the *Times*, the *Morning Chronicle*, and other daily journals were sown broadcast over the land. A further step was made in 1832, when the publication of the *Penny Magazine* inaugurated a new era, the era of Books for the Million. *Chambers' Journal*, *Household Words*, the *London Journal*, and other periodicals, widely different in standard and merit, but all appealing to the newly developed love of reading in the so-called 'lower classes,' issued weekly their thousands and tens of thousands. The Printing-press, through the skill and labour of ingenious inventors, has kept pace with the popular demand. The penny newspaper is enabled to throw off its 20,000 impressions per hour, so that metropolitan news of the previous day can now be read in less than twenty-four hours afterwards, at John o' Groat's House or Land's End. This diffusion of newspaper and magazine literature has not interfered with the extension of the book trade, and not less than 3000 or 4000 new works are now annually produced by the printing-presses of Great Britain. Nor is the contrast in the number issued greater than the contrast in price. The mechanic can solace himself with Scott's wonderful fictions at sixpence per copy. The romances of Lord Lytton and the novels of Dickens sell at 1*s.* 6*d.* and 2*s.* each. An excellent edition of Shakespeare, well printed, and on good paper, may be obtained for 3*s.* 6*d.* The present publication, half a century ago, would have cost 10*s.* a part, instead of 2*s.* Equally great is the difference in workmanship. Putting aside the elaborate productions of the great printers, our ancestors had no works worthy of comparison with those of the present day for typographical excellence, and the shilling volumes now are better 'got up' than the half guinea and guinea volumes which formed the libraries of a Sir Roger de Coverley and a Parson Adams. Our English and Scotch printers in many branches of their art surpass the Continental, while, fifty years since, they could not even approach them. Colour-printing, moreover, has attained to a wonderful degree of excellence, though it can scarcely be said to have existed as an art until Mr. Savage, in 1819-22, published his 'Hints on Colour-printing.' Mr. George Baxter, in 1836, produced some excellent specimens in oils, in some of which he employed twenty different blocks. It was afterwards applied to LITHOGRAPHY, under the name of Chromo-lithography, which has been developed to a remarkably successful extent. Mr. A. C. Leighton, in 1851, commenced colour-printing by machinery, and has succeeded in producing admirable imitations of water-colour drawings, at comparatively low cost. Illustrated books have become a feature in our current literature. Their number, their cheapness, their merit, would alike excite the wonder and astonishment of our forefathers.

Scotland and Ireland.—The art was introduced into Edinburgh about thirty years after Caxton established his Printing-press in Westminster Abbey. James IV., by patent, authorized Walter Chapman and Andrew Mollar to print books, in 1507, and the first work

issued is said to have been 'The Portens of Nobleness.' Glasgow has also long been favourably known for its superior typography. Both cities are noted for their typographers, and issue works not unworthy of comparison with the best produced by London printers.

In Ireland the art was unknown until 1551, and it made but little progress until the eighteenth century. At present it is most successfully cultivated in Dublin and Belfast.

The Continent.—The French printers have always ranked foremost among the brotherhood of Gutemberg and Schœffer. The presses of Paris produce work of surpassing merit, and at Tours, Orleans, and other provincial towns, large establishments are successfully conducted. The number of sheets printed yearly, of all kinds, is computed at 140,000,000.

In Germany the progress of the art has been hindered from political causes; but between 5000 and 6000 books are issued annually, and the famous Book Fairs of Leipzig attract purchasers from France, Denmark, Switzerland, and even Britain. At Vienna the Imperial Printing Office has been developed into an establishment of the highest importance, which is famous for its experiments in nature-printing and all the more recent discoveries in appliances connected with every branch of the profession, and for its vast collection of ancient and oriental types. It has issued the Lord's Prayer in 200 different languages and dialects, each printed in its proper characters.

United States.—The activity of the Press in the great American Republic is a curious illustration of the energy and vivacity of the American character. There are at least 15,000 printers in the United States, but their work is not generally equal to the British in beauty or durability. It is, however, singularly low-priced. The first press in the American colonies was established at Cambridge, in Massachusetts, in 1638.

We shall now proceed to give a short description of the art in its principal branches, without, however, unnecessarily entering upon technical details.

The term 'printing' is applied generally to several distinct branches of the art—1st. Printing with movable types, such as books, &c., usually known as *letterpress printing*, from *raised* surfaces; 2nd. Printing from engraved copper or steel plates in *intaglio* [ENGRAVING]; 3rd. Obtaining impressions from *flat* drawings or transfers on stone, called LITHOGRAPHY. It is the first of these mainly we shall now describe, referring briefly in the sequel to the second branch; the third will be found under its own title.

Two special classes of workmen are generally employed in a Printing-office, viz., *compositors*, who 'set up' or arrange the types into lines and pages, according to the MS. furnished by the author (technically called 'copy'); and *printers* (pressmen or machinists), who work off the impressions upon paper. In addition to these, however, numerous other branches of industry have been introduced, more or less requisite, according to the class and extent of work carried on.

COMPOSING.

Type.—The types employed differ greatly in size according as they are intended for *job-printing* or *book-printing*, the former including such work as hand-bills, posters, &c., and only limited in variety by the taste of the type-founder. Book types include fourteen regular bodies or founts, from *Great Primer*, which is the largest, to *Brilliant*, the smallest type used for printing books, as follows:—Great Primer, English, Pica, Small Pica, Long Primer, Bourgeois, Brevier, Minion, Emerald, Nonpareil, Ruby, Pearl, Diamond, and Brilliant. There are in addition numerous other sizes, called 'bastard' founts, which bear the face of one fount on the body of another, such as Bourgeois on Long Primer, and called Long Primer Bourgeois. *Pica* forms the standard of measurement adopted for the various materials used by compositors, such as leads, furniture, &c., all other founts also bearing a certain proportion to it. [TYPE.]

Composition.—The compositor stands before a 'frame,' projecting from the wall at a convenient angle, on which are placed the cases filled with type, technically known as an *upper* and a *lower* case. Each case is divided into small compartments, or *boxes*, one for every letter or character: the upper, with ninety-eight boxes, contains the *capital* and *small capital* letters, accents, and such characters as are least often wanted: the lower, with fifty-three boxes, which are of four different sizes, comprehends the small letters, figures, points, spaces, quadrats, &c. The letters most frequently used are placed nearest to the compositor's hand, and in the greatest abundance; these are a, r, t, u, m, n, h, o, p, c, d, e, i, and s. The *spaces*, which are simply *shanks* of letters without faces, cast one-fourth lower than the body, are required to separate one word from another; they all bear a certain proportion to each other. *Italic* letters are retained in separate cases.

Having received instructions as to the type he must use, the width of the page, and other details, the compositor places his copy on the back of the upper case before him, and takes in his left hand an instrument called a *composing stick*, usually made of iron, and resembling a small frame, capable, by means of a screw and a movable slide, of being adjusted to the different widths employed in printing. As soon as he has screwed up his stick to the proper width, he lays in it a *setting rule*, or smooth piece of brass, which is of the same width as the measure, and as high as the type, and proceeds to pick up his letters, spaces, and points, one by one, with a quickness that depends upon his skill and experience. A good compositor will 'set up' 2000 types in an hour. He looks not at the face of his types, as he concludes each will be in its appropriate box, but glances rapidly at a *nick* cast on the under side of each type, which he places with the nick outside of his rule. He secures each letter with the thumb of the left hand, placing the types side by side in a line from left to right. When he has come to the end of his setting rule, he knows he has finished a line. But it may happen that the line ends in the middle of a syllable, thus:—

Where it is indigenous, and which by Europeans is tho

Now he must either get into the line the whole of the word 'thought,' or must 'space out' the preceding words so as to complete the line without it. This is called 'justification,' and is a difficult process. To secure uniformity of appearance, one word must not be too far apart from another, or too close to it. Either fault, as the following example shows, would injure the look of the page:—

Where it is indigenous, and which by Europeans is

The compositor, therefore, has to arrange his 'spaces' in such a manner as to please the eye of the reader, and preserve an uniformity of distance between every word. It is in this part of his work that the taste and skill of a good workman are peculiarly apparent; in giving his composed matter an uniform appearance, neither too white nor too dark.

Line after line is thus set up and justified, until the composing stick is full, when the compositor clasps the mass of metal by the rule and between the thumbs and first and second fingers of both hands, and deposits it upon an oblong tray of wood or metal, with a half-inch edge at the top and left side, called a *galley*. When a considerable amount of matter has thus been collected in galleys, the compositor proceeds to divide it into pages and sheets, with proper headlines, folios, and signatures, and binds each page round securely with cord. This done, he lays them down on the *imposing stone*—which is generally a flat block of iron or marble, mounted on a strong wooden framework—and 'imposes' them. This operation consists in placing the pages in such a position that, when printed and folded, each page will succeed in its proper order. He then takes a rectangular frame of iron, called a '*chase*,' of the size of the paper about to be used, and having two iron transverse bars, called a long and a short cross—which is placed round the pages. Now, between the chase and the various pages a space intervenes. This space the compositor proceeds to 'dress' or fill up with pieces of 'furniture,' which are simply slips of wood or metal of different thicknesses, placed, some at the head ('head sticks'), some between the pages ('gutters'), and some at the sides and bottom ('side' and 'foot sticks'). These he wedges together by small wooden 'quoins' into a perfectly firm and solid mass or 'form,' which, having first been carefully levelled, is then 'locked up,' and may be carried from place to place without shifting a letter. A 'form' of this Encyclopædia, which is 'set up' in brevier type, contains sixteen pages, and about 110,000 separate letters and spaces.

The form is now placed upon the press, and a first impression taken or pulled, which is called the 'first proof.' This is revised and corrected by a 'reader,' while a 'reading boy' reads aloud the author's copy. As soon as this is done the proof is handed to the compositor, who 'unlocks the form,' picks out the wrong types with a sharp awl or 'bodkin,' and inserts right ones. From the corrected form another impression, or 'revise' is taken, which, after further examination, is forwarded to the author, who in his turn makes what alterations he thinks necessary, and returns it to be printed.

In addition to a thorough knowledge of the numerous peculiarities pertaining to book-work, the compositor's art necessarily requires considerable readiness in comprehending the subject on which he is engaged, together with the exercise of skill and good taste in the display of general job-work—combining dexterity with precision and accuracy.

Distribution.—The compositor's work is not finished when the pages which he has helped to 'set up' are sent to the press. As soon as the required number of impressions has been taken, or the form stereotyped [STEREOTYPING], it is returned to the compositor, who has next to 'distribute' the letters into the various boxes of his cases before they can be again used for fresh matter. This process is rapidly performed. Having removed the furniture and damped the type, he takes up a number of lines on his composing rule, and, lifting up and reading several words at a time, proceeds, by a dexterous motion of his right hand finger and thumb, to throw off the various letters into their respective boxes.

Signatures.—These are usually small capital letters placed at the bottom of the first page of each sheet, commencing with A, but omitting J, V, and W. They seem to have been first made use of by Antonio Zorat, at Milan, in 1470. Signatures are necessary in folding and binding sheets, being usually the only guide in these operations. Figures are sometimes used instead of letters in signatures, beginning with 1 instead of A.

Type-Composing and Distributing Machines.—Numerous attempts have been made to increase the manipulative power of the compositor in type-setting by the aid of machinery. Most of these machines have been based on the principle of selecting and liberating each letter by depressing a corresponding key on a key-board, similar to the clavier of a pianoforte. Some of these machines operate only on the *lower-case* letters, while others include the capital letters. One of the earliest was introduced by M. Ballanche, of Lyons, about 1841. At the Exhibition of 1851 a machine for composing and distributing was exhibited by M. Sörenson, of Copenhagen. Since then, several other machines have been devised, both in Europe and America, some of which were shown at the Exhibition of 1862 and 1867. In Plate 1, 'Printing,' prefixed to this volume, we have given two illustrations, which have been chosen simply as specimens of a class, and without reference to merit. Fig. 1 represents in perspective Mitchell's American 'type composer;' and fig. 2, the 'distributor.' The form of the *compositor* is in plan a right-angled triangle, placed horizontally, with a key-board, *a*, at one of the sides, containing thirty-nine keys, representing the principal lower-case letters and other sorts. Each key, when pressed, liberates a type from one of an equal number of slides or type-holders, *b*, standing at an incline upon the machine in a row nearly parallel with the key-board, and immediately above a series of endless tapes or bands, *c*. The type thus liberated is conveyed upon one of these tapes to another band, forming the hypothenuse of the triangle, *d*. On arriving at the end of this band it is carried on by a notched or serrated wheel, called the 'setting wheel,' placed upon its end, and pushed forward to make room for the succeeding type. Words are thus rapidly composed in a long line of about thirty inches, whence they are removed and justified into lines of the required length in the usual way. In convenient proximity with the key-board are narrow cases containing capital and italic letters, together with other requisites, which, however, require to be placed separately by the workman into a special channel for conveyance to the 'setting-wheel.' The principle of the machine consists in the combination of bands of different lengths, so as to enable the types to reach the wheel in the order in which the keys are struck.

The *distributor*, which is self-acting, is much smaller, and of a circular form, containing a series of slides to hold the type, *a*, and requires every type to be specially nicked on the back, according to a graduating scale. The lines of type to be distributed are placed successively in a narrow channel above the machine, *b*, in which they are pressed forward to a vibrating metal finger, *c*. By this finger each type is pushed aside and dropped on to a bevelled grooved wheel, *d*, revolving horizontally below. In the grooves of this wheel are placed small pins, on which the types are hung by means of the nicks; the ends of the types projecting below the under surface of the wheel at distances varying according to the position of the nicks. Each letter is thus carried round on the wheel until it meets with a corresponding projection below, when it is tilted off and dropped into the slide, where they remain set up ready for the 'compositor.'

Fig. 3 is an illustration of Young's composing machine, and conveys a vivid idea of the operation.

In this machine the types are also contained in slides immediately above the key-board. When a key is struck by the operator, a type is pushed out of its reservoir by means of a small lever and rod, and is then caused to slide down a special groove or channel in an inclined plane, and thence into a receiver, where the types are set up side by side in rows, which are afterwards justified into lines. A very ingenious 'distributor' also accompanies this machine.

These machines are obviously best adapted for 'plain matter,' where few italic or capital letters are required, frequent recurrence to these seriously depreciating the productive power of the machine, and hence they cannot be applied so generally as their aim would seem to indicate; so that, notwithstanding the wonderful ingenuity displayed in their construction, and the fabulous results claimed by inventors, type-composing machines have not as yet (1867) been successful, though it is to be hoped that eventually some contrivance will be devised by which the most mechanical and tedious section of the compositor's art may be accomplished in a more rapid and economical manner.

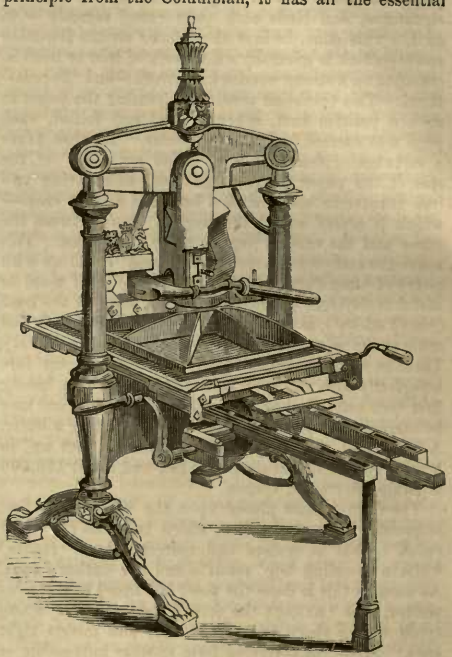
PRESS-WORK.

Printing Press.—In the early days of the art the Printing Press was a sufficiently rude affair. It was made of wood, with an iron screw, resembling in appearance an ordinary screw-press, with a contrivance for running the inked form of type under the point of pressure: to the lower end of this screw was attached a flat horizontal piece of wood, called the *platen*, which, being brought down by means of the screw, pressed the paper upon the face of the types, and thus an impression was obtained. Great improvements were introduced into this rough mechanism by Willem Jansen Blaew, an ingenious mathematical instrument maker of Amsterdam. In the press which he constructed the form of type was placed on a carriage and wound below the point of pressure, and the pressure given by moving a handle attached to a screw hanging in a beam with a spring, which spring caused the screw to fly back as soon as the impression was taken. Fig. 1, Plate 2, gives, in perspective elevation, an illustration of the old wooden press, with the balls used for inking the type.

This species of press, which was almost wholly constructed of wood, continued in use all over Europe until the year 1800, when a more manageable piece of mechanism was constructed by the ingenious Earl Stanhope (fig. 2, Plate 2). The *Stanhope Press* was made of iron, the principal improvement being in the motion by which the screw was made to descend. The bar or handle, H, was fixed to an upright spindle, M, to which a lever was attached, connected with a second lever fixed to the top of the screw by a connecting bar. These two levers, P P, being placed at different angles to each other, when the platen is brought down to the face of the form, they take such a position with each other as to act with great advantage, and secure a wonderful increase of power; so that the pressman could not only print larger sheets of paper, and in a superior manner, but with greater ease and rapidity. Earl Stanhope's invention was followed by a number of modifications, in some of which the screw was dispensed with, the pressure being given by levers or joints. Of these we shall only notice two, as combining in their construction the principal features of all other modern hand-presses.

The *Columbian*, invented by Mr. G. Clymer, of Philadelphia, was introduced into this country in 1817. In this press the power is given by a series of levers, the return of the bar and levers being effected by means of counterpoises. For large and heavy forms, this press is much preferred, the leverage enabling the workman, as it were, to feel his way down to the very face of the type, thereby tending very much to delicacy and exactness in printing.

The *Albion*, invented by Mr. R. W. Cope, of London, is represented in the annexed engraving. Differing in principle from the Columbian, it has all the essential



requisites of a hand-press—speed, light pull, and great durability. In this press the impression is given by a knuckle-joint. The two parts of this joint lying at a slight angle, when the pull is made they are brought into line with each other, and the platen is thus brought down to an equal extent. The return is effected by a strong helical spring inclosed in the upright projection upon the head of the press, as shown in the illustration.

In connection with fig. 2, Plate 2, the process of printing may be described. In working a hand-press, two workmen are required—one to ink the form and attend to the colour of the impressions, the other to lay on the sheets and work the press. The form, A, being laid on the carriage, E, of the press, is firmly secured at the sides, in order to render it immovable while working. A blank sheet of paper, similar in size to that to be printed on, is then carefully folded according to the crosses of the *chase;* this sheet is next carefully opened up and laid on the form with the precise margins required in printing. The tympan, B, being slightly damped, is closed down on the form and an impression taken; when brought back, the sheet adheres to the tympan, where it is fixed, and serves as a guide for the subsequent 'laying on' of the paper to be printed. This sheet is termed the 'tympan-sheet.' The next operation is to secure *register* (one of the greatest niceties connected with the art), *i.e.*, to arrange so that not only every page, but every line, shall fall exactly upon the corresponding

line or page on the opposite side of the sheet. To secure this effect, the form having first been thoroughly squared and adjusted, points are selected (small pieces of fine-pointed wire), D, and attached to the centre of the rim of the tympan; these produce small perforations in the centre of the sheet during the first impression, and the sheet being laid on, in the second impression, exactly on the same holes, the impression is found to correspond. The tympan, which is in two pieces, is formed of parchment, rigidly stretched on slight iron frames, the two parts fitting into each other, but leaving space for a blanket or other material to be placed between them; the whole being connected to the carriage by a hinge, and folding down upon the form like the lid of a box. To lift the sheet off the form when it is printed, a skeleton-like frame, termed a *frisket*, C, is made use of, which is in turn hinged to the upper end of the tympan. The frisket is made of stout paper, stretched upon a slight iron frame, on which, an impression having been pulled, all the printed portions are subsequently cut away, and serves the double purpose of retaining the sheet and preventing its being soiled.

Having proceeded so far, the pressman next prepares to *make ready* his form, which is done in the following manner:—Laying a sheet of white paper carefully over the tympan-sheet, he closes down the frisket over it, shuts down the frisket and tympan upon the form, runs the carriage under the platen, F, and pulls the bar, H, with his whole weight until it has gone its full extent; the platen is thus made to descend, and an impression is produced. Gradually releasing his *pull*, the bar returns to its original position, the carriage is run back, and the tympan and frisket raised. The sheet is then removed from the points and examined. The first impression is generally very defective and irregular—the parchment of the tympan may be of unequal thickness, the blanket worn thin, or the type not level; with forms of stereotype plates the irregularity is still more increased. To remedy these defects he then proceeds to make an *overlay*, which is done by filling up all deficiencies in the sheet by pasting on corresponding pieces of paper, and cutting away all the heavy portions. When finished, this sheet, which is called a *skeleton*, is placed inside the tympan, along with the blanket. This operation is repeated until the impression is made thoroughly regular, when a properly printed sheet is submitted to the overseer, who, if satisfied, directs the pressman to proceed. In making ready stereotype plates, underlays are placed below the plates, in addition to the regular overlay.

In the preparation of wood engravings the highest skill of the workman is developed. A glance at any well printed 'cut' will show how the lights and shades are graduated, all of which is effected by the *overlay*, the surface of the block being level. Formerly wood engravings were burnished lower in light places; but experience has proved that this can be best accomplished by means of the overlay, which is made to give the proper amount of impression on the different parts of the engraving; the deeper shades requiring more and the lighter parts less impression.

In printing the second side of the impression, a clean sheet, which has to be frequently renewed, is placed over the face of the tympan, in order to prevent the sheets from being soiled by the 'set-off' of the damp ink which the pressure produces.

In working the press, the two pressmen alternately take the duties of *pulling* and *inking*. When finally worked off, the forms are washed with lye and water to remove the ink [INK], and taken back for distribution.

Inking and Rollers.—Much of the beauty of fine printing depends on the care exercised in the operation of *rolling* or *inking*. In the earliest stages of the art, ink was applied by stuffed balls or cushions covered with skin, which have, however, been entirely superseded by composition rollers, first introduced about 1814–15. These rollers are made of a mixture of treacle and glue, which, being rendered fusible, is poured into an iron mould, in which the central rod (usually of iron, with a coating of wood) has been previously inserted. When taken from the mould, the roller is a simple cylinder of soft elastic matter, and cannot be used until it has attained a particular firmness, varying according to the work for which it is intended.

Standing directly in front of the inking-table, as shown in fig. 3, Plate 2 (usually made of polished iron), the workman places a little ink upon it, which he distributes upon his roller by drawing it backwards and forwards upon the table. He then applies it to the surface of the form in the same way, again rolling backwards and forwards to insure its being thoroughly gone over.

An ingenious self-inking apparatus has been devised, attached to the press, and working by mechanism. By this arrangement, where long numbers are being printed, a great saving of manual labour is effected.

Paper.—Before the paper is ready for printing it requires to be damped for several hours, in order that the ink may adhere more readily. This is done by dipping alternate quires in water, and afterwards pressing the mass with heavy weights, or by the hydraulic or screw-press, till the whole is in an equally damp condition. For finer work, it is not unusual to calender the paper before printing. [PAPER.]

Warehousing.—From the printer the sheets are passed to the warehouseman, by whom they are hung up in the drying room on wooden frames to dry, a process which may be effected with variable speed, according to the degree of heat applied, heated air being the method most preferred. When sufficiently dried, they are individually placed between fine glazed boards, with iron plates, &c., and in this condition subjected to powerful hydraulic pressure; when extracted the sheet is found to be quite smooth, and all the type indentations levelled. For finer works, the sheets are calendered between copper boards. This process communicates the rich polish and smoothness which adds so much to the appearance of a well printed book. From the warehouse the printed sheets are next transferred to the bookbinder. [BOOKBINDING.]

PRINTING MACHINES.

It is obvious that by the most improved hand-presses the labour of printing must be great, and that no extraordinary expedition could ever be possible. The hardest work and the highest skill could not turn out more than 200 perfect copies of a newspaper per hour; consequently, as a taste for reading increased, and more rapid production became necessary, in order to publish them in time two or more forms of type were set up, and worked off simultaneously at as many presses. The great expense thus incurred made it desirable to secure some more expeditious method of obtaining impressions from type, and finally led to the great improvements of recent years in printing machines.

In the year 1790, Mr. Nicholson, editor of the *Philosophical Journal*, took out a patent for certain improvements in printing; and it is remarkable that in this patent he lays down almost every principle which has since been successfully applied to Printing Machines. His chief plan was to form the types upon a tapering

body, so that they might be placed on the surface of a cylinder, and kept compact like the voussoirs of an arch (figs. 4 and 5, Plate 2).

With him, however, the ideas remained ideas; he did not translate them into facts. The first working machine was constructed by Mr. König, a German, who, coming to England about 1804, submitted his invention to Mr. Bensley, the printer, and Mr. Taylor, a scientific writer of repute. This machine comprised the two principal features of Mr. Nicholson's patent—the cylinders and inking rollers. They encouraged him to proceed. He next obtained an introduction to Mr. Walter, proprietor of the *Times* newspaper, who at once saw the advantages of the projected machine, and assisted Mr. König in carrying it into a reality; and on the 28th of November, 1814, he was able to announce to the readers of the *Times* that they held in their hands a newspaper printed by steam-propelled machinery. In König's machine the type passed under a cylinder, on which was wrapped the sheet of paper, the paper being secured by means of tapes. The ink was placed in a cylindrical box, and forced from it by a powerful screw, depressing a tightly fitted piston; thence it fell between two iron rollers, below which were placed other rollers, two having, besides their rotary motion, an end motion, that is, a motion in the direction of their length. The whole system of rollers terminated in two, which applied the ink to the types, fig. 6, Plate 2.

As yet only one side of the sheet was printed at a time; but the utility of cylinder printing having been proved, it became desirable to apply the principle to the execution of book-work, where printing both sides of the sheet, together with accurate register, was necessary.

By multiplying the cylinders, and other modifications, Mr. König contrived to print both sides. The sheet was conveyed from one cylinder to the other by means of tapes; the course of the sheet resembling a couple of abrupt curves, as shown in fig. 7, the sheet being turned over as it moved. This machine turned out 750 sheets per hour, printed on both sides, and was considered by the patentees to be incapable of further improvement.

In a machine constructed by Messrs. Donkin & Bacon, inking rollers, covered with a composition of treacle and glue, were first used. The rollers had formerly been covered with leather, and had never answered properly.

In 1818 Messrs. Applegath & Cowper took out a patent for improvements in cylindrical printing machinery —the chief being the application of two drums placed between the cylinders to secure accurate registering, over and under which the sheet is conveyed in its progress from one cylinder to the other; and the mode of distributing the ink upon flat movable iron tables. Plate 3 represents one of Applegath & Cowper's ordinary perfecting machines, as originally patented. Machines constructed upon these principles are now in use for book-work in all our principal printing establishments. They are moved by steam power, and require the attendance of two boys. The machine is about 15 feet long by 5 broad, with two cylinders, each about 9 feet in circumference, and placed about 2 feet apart. The *modus operandi* is as simple as it is ingenious, and in general terms may be thus described:—

The blank paper which is to be printed is laid on a table, A, by the side of which, on a raised platform, stands a boy, called the *layer-on*, who places the paper, a sheet at a time, upon the *feeder*, B, which has a number of linen girths or tapes passing across its surface, and extending to a roller at each end of the feeder, so that when the rollers are partially turned round, the motion of the girth carries the sheet forward under the *web roller*, C, and the *smoothing roller*, D, and delivers it over the *entering drum*, E. The partial revolution of the feeder is accomplished by attaching to its axis a small quadrant; this is raised by means of a large wheel, to the side of which is a toothed segment, so that for every revolution of the large wheel the quadrant is made to revolve through a space sufficient to cause the feeder to carry in the sheet, and when the toothed segment has passed the quadrant, the latter falls down again, ready to be raised as the wheel comes round. By this means, provided a sheet of paper be placed upon the feeder once during every revolution of the large wheel, the quadrant takes it into the machine at the right moment, and thus prevents it from occupying a wrong position, or interfering with the sheet which is actually being printed. The feeder then delivers the sheet of white paper to the entering drum, where it is seized by the systems of endless tapes, which pass over a series of rollers to keep them extended. These tapes are so contrived as to fall between the pages of the printing and on the margins or edges of the sheet: this allows them to remain in contact with both sides of the sheet during its entire passage through the machine, and in this way the paper is conveyed from the one printing cylinder to the other, without disturbing the *register*, or coincidence of the pages on opposite sides of the sheet. As the sheet is carried along between the tapes, it applies itself to the blanket on the printing cylinder, F, revolving below which it receives the first impression; the sheet, now printed on one side, is carried *over* H and *under* I to the blanket on the cylinder, G, where the sheet is found to be inverted, the printed side being next to the blanket, and the blank side outward, which, meeting the second form of type at the proper moment, receives the second impression, and completes the sheet. On reaching *i*, where the two systems of tapes separate, the perfect sheet is thrown out into the hands of the *taking-off* boy. The printing cylinders are of iron, turned quite true, and are covered with *blankets* of fine woollen cloth. They are mounted on strong axes, which turn in bearings attached to the main frame of the machine, which can be adjusted, by means of screws, to suit the amount of pressure required. The cylinders and the drums are all connected by toothed wheels, so as to insure an uniform and steady motion.

The conveyance of the sheet with accuracy and speed by means of the tapes is an important feature of the double-cylinder machine, and will be readily understood by reference to the diagram, fig. 2, Plate 3. One system of tapes may be said to commence at the feeding apparatus, E; from this they proceed in contact with the right hand side and under portion of the printing cylinder, F; they then pass over one conveying drum, H, and under another, I, whence they proceed to compass the left hand side and under portion of the printing cylinder, G, and by passing in contact with four small rollers, *a*, *b*, *c*, *d*, they arrive again at the feeder, E, thus forming one of the series of endless tapes. The other system of tapes corresponds with the first in number and position in such a way, that the sheet of paper, so long as it is grasped between them, may be held securely and yet in constant motion. Commencing at the roller, *h*, they descend therefrom to the entering drum, E, where they meet, and are afterwards carried together to the roller, *i*, where they separate. From *i* the tapes descend to a roller at *k*, and by passing in contact with rollers at *m*, *n*, they arrive at the point from which they began, *h*; the two systems of tapes thus act continually in concert, without interfering with each other.

PRINTING.

TYPE COMPOSING AND DISTRIBUTING MACHINES.

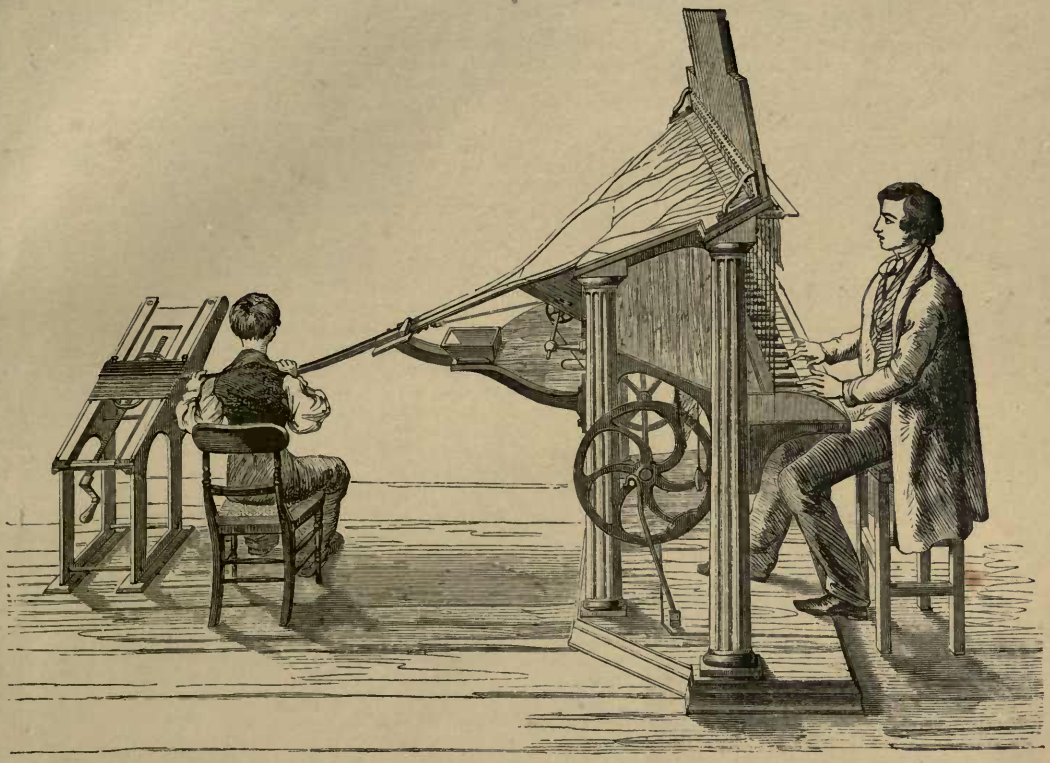


FIG. 3.—YOUNG'S TYPE COMPOSER

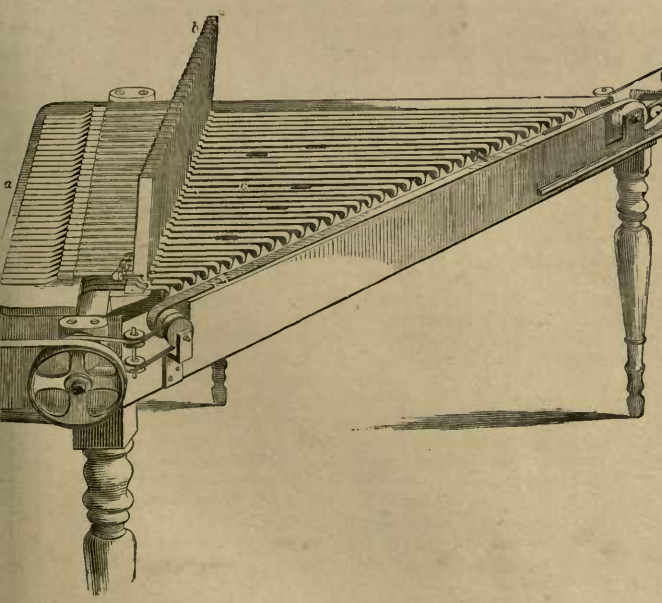


FIG. 1.—MITCHELL'S TYPE COMPOSING MACHINE.

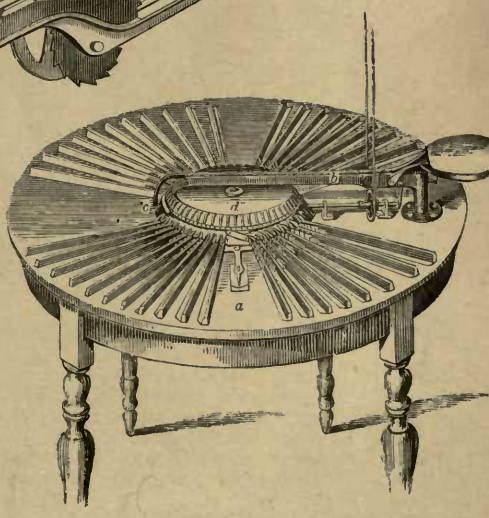
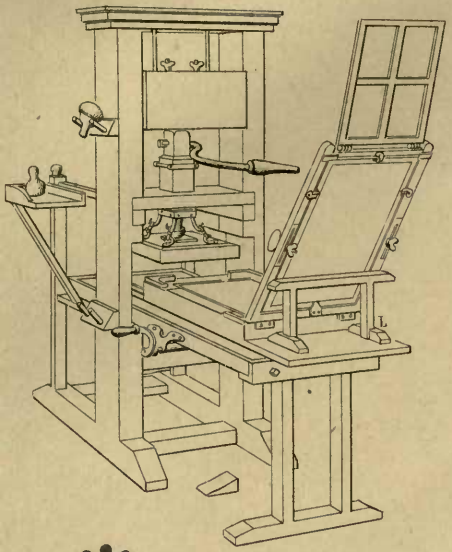


FIG. 2.—MITCHELL'S TYPE DISTRIBUTOR.

Old Wooden Press

Fig. 1



Cowper's Inking Table and Roller

Fig. 3

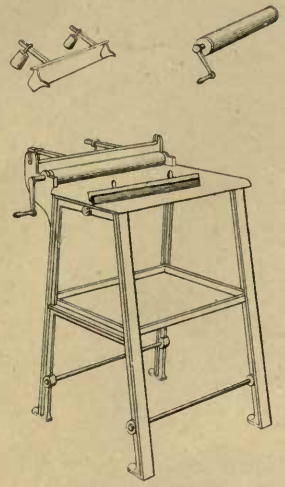
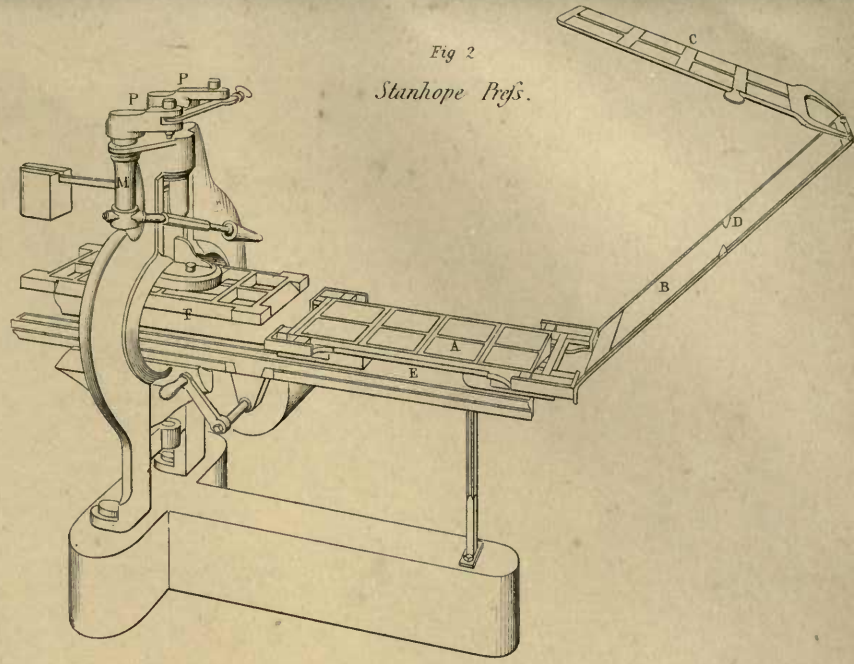


Fig 2

Stanhope Press.



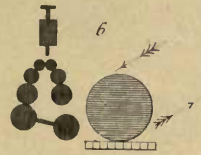
4

Nicholsons for arched Type.

5

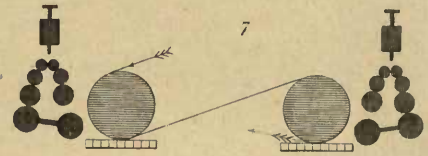
Nicholsons for common Type.

6



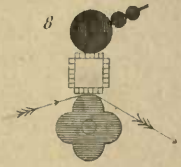
Koenig's single for one side of the sheet.

7



Koenig's double for both sides of the sheet

8



Donkin and Bacons for Type.

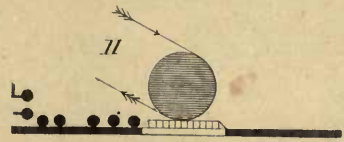
9

Cowper's single for curved stereotype.

10

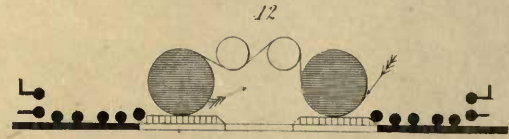
Cowper's double for both sides of the sheet.

11



Applegath and Cowper's single.

12



Applegath and Cowper's double.

Fig. 2.

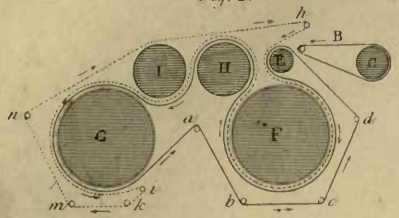
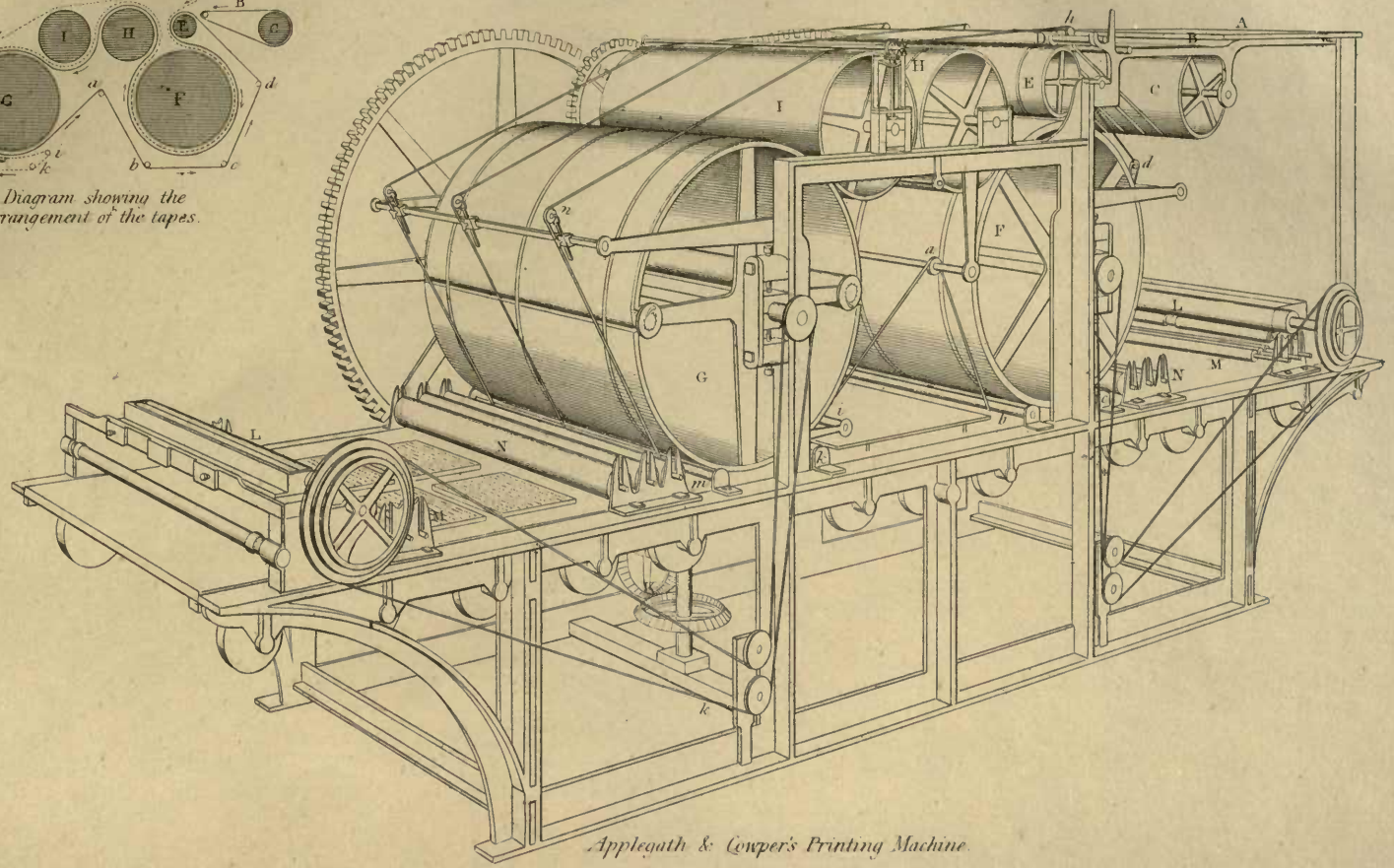
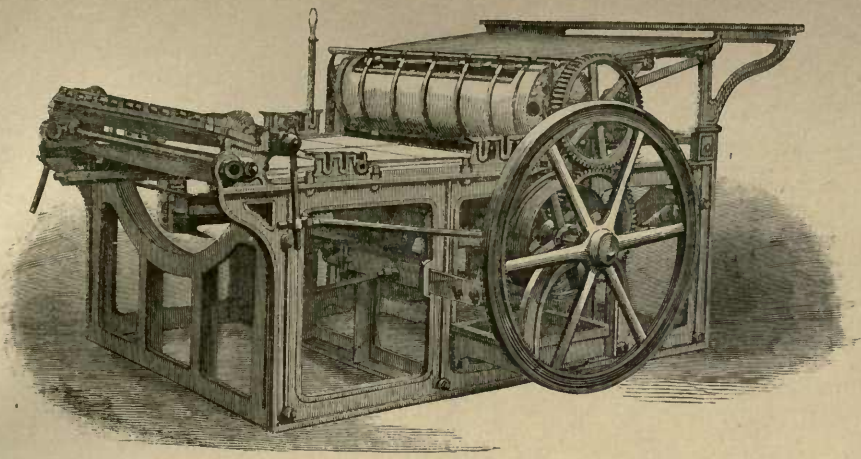


Diagram showing the arrangement of the tapes.

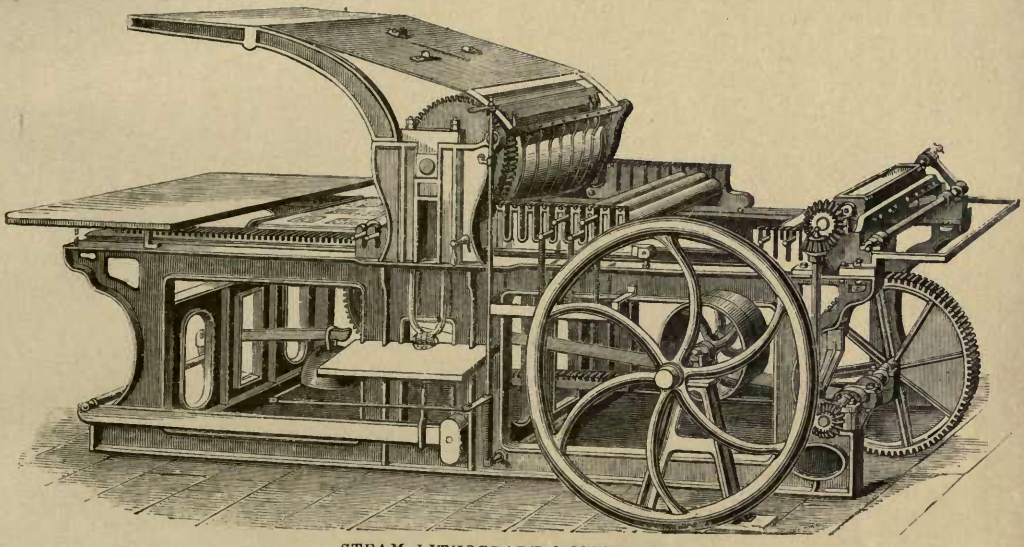
Fig. 1



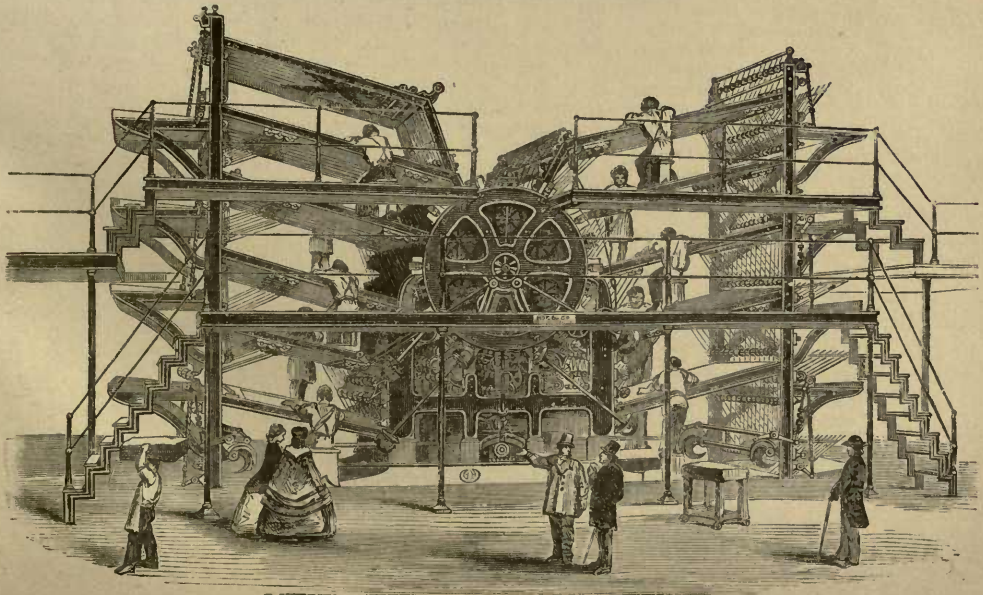
Applegath & Cowper's Printing Machine.



FAST SINGLE-CYLINDER JOBBING MACHINE.



STEAM LITHOGRAPHIC MACHINE.



HOE'S FAST 10-FEEDER AMERICAN PRINTING MACHINE.

The two forms of type required to print the sheet on both sides are placed at a certain distance from each other on a long carriage, and close to each form is an inking table, consisting of an extended metal surface, also supported by the carriage. The carriage, with the two forms of type and inking tables, moves backwards and forwards on rollers, and in its progress brings the type at the proper moment in contact with the sheet of paper on one of the printing cylinders. This reciprocating movement is effected by a pinion working into the alternate sides of a rack under the tables, and motion is given to the pinion by bevel wheels, K.

The mechanism for supplying and distributing the ink upon the type is one of the most important sections of the machine, and is performed by means of elastic rollers, as formerly mentioned, of which there is a similar set on either end of the machine. The ink is contained in a duct, in which a metal roller, L, revolves, motion being given to it by a band from the printing cylinder, G. A small vibrating roller is made to work between the ductor roller and the inking table, delivering a small regular quantity upon it each time it arrives at either end of the machine. Three or four diagonal rollers, M, which rotate entirely by the friction of the table, distribute this ink on the table, whence it is taken and delivered upon the type by rollers, N, as the forms of type pass below them.

Machines such as the one now described will throw off from 1000 to 1200 perfect sheets per hour. Single cylinder machines of this class are employed for provincial newspapers, throwing off about 800 impressions per hour, printed on one side only; the second impression being reserved for the receipt of intelligence up till the latest hour for going to press.

The small diagrams on Plate 2, figs. 4–12, will convey an idea of the varieties of inking apparatus and arrangements of machines from their introduction. Fig. 4 is Nicholson's machine for arched type; fig. 5, Nicholson's machine for common type; fig. 6, König's machine for one side of the sheet; fig. 7, König's for both sides; fig. 8, Donkin & Bacon's for one side; fig. 9, Cowper's for curved stereotype and one side of the sheet; fig. 10, Cowper's for both sides, with curved stereotype; fig. 11, Applegath & Cowper's for one side, and for common type; and fig. 12, Applegath & Cowper's for both sides of the sheet, as now in use, and described above. In all these diagrams, the *black* parts represent the inking apparatus; the *diagonal* lines represent the cylinders on which the paper revolves to receive the impression; the *perpendicular* lines represent the types or plates; and the *arrows* indicate the track of the sheet of paper.

The enormous increase in the circulation of newspapers, however, demanded a corresponding increase in their production; and in 1848 a new machine was constructed by Applegath for the *Times* newspaper. This machine had a vertical cylinder, 64 inches broad, on which the type was fixed, surrounded by eight smaller cylinders, each about 13 inches diameter, and covered with cloth, round which the paper was led and delivered by tapes, each impression cylinder having a feeding apparatus, with two attendants for feeding and taking off. The inking rollers were also vertical, and had accompanying ink reservoirs, the type being successively inked in turn after each impression. The form was placed on a part of the large cylinder, the surface of the type forming a portion of a polygon, and regularity of impression was produced by pasting strips of paper on the impression cylinder. By this machine 11,000 copies per hour were thrown off.

Notwithstanding the great productive powers of Applegath's machine, the still increasing requirements of the *Times* and other newspapers made it necessary that something more should be effected. In this emergency an American machine, the invention of Messrs. Hoe & Co., of New York, was successfully introduced. It is called 'The Type Revolving Fast Printing Machine,' and is made with from two to ten impression-cylinders. Fig. 3, Plate 4, is an illustration of a ten-cylinder Hoe machine. Hoe's process consists in placing the types on a horizontal cylinder revolving on its axis, against which the sheets are pressed by smaller exterior cylinders. The pages of type are arranged in segments of a circle, each segment forming a frame that can be fixed on the cylinder. These frames are technically termed *turtles*. Each column of type stands on a level strip of the turtle, while between the columns the rules for printing the lines are of a bevelled shape—the bevel corresponding to the convexity of the turtle; so that, by means of this bevelling, the form of type is capable of being tightened up and held upon the press. The type forms occupy only a portion of the cylinder, the remainder affording space for the inking apparatus. The smaller surrounding cylinders for giving the impression are arranged in a framework, in connection with inclined tables, from which the sheets are fed; the taking off being performed with great regularity by means of a self-acting frame or flyer, which rises and falls with each impression of the printing cylinders. The size of the main cylinder, the number of exterior cylinders, and the rate of speed at which the machine is driven, determines the number of copies printed per hour.

The working of a six-cylinder machine is thus described: 'The large cylinder being put in motion, the type imbedded in it is carried, successively, to the six impression-cylinders, which are placed horizontally to the large one, and arranged at proper distances around it. These subsidiary cylinders give the impression to six sheets of paper introduced, one at each cylinder. For each impression-cylinder there are two inking-rollers, which revolve on the distributing surface, and take up a supply of ink, and, at the proper moment, pass over the type, giving it the requisite amount of ink, after which they again fall to the distributing surface. Six persons are required to feed in the sheets, which, after receiving the impression, are carried out, by means of tapes, to the end of the machine, and laid regularly in heaps by self-acting flyers.'

The first Hoe machine introduced into Europe (with the exception of one made for a Paris newspaper in 1848) was one with six cylinders for *Lloyd's Weekly Newspaper*, in London, in 1857. These were followed by two ten-cylinder machines for the *Times*, manufactured by Mr. Whitworth, of Manchester; and they have now been adopted in all the principal newspapers throughout Great Britain. They are driven at the rate of thirty-two revolutions per minute, which, for a ten cylinder machine, gives a printing rate of 19,200 per hour, or of 16,000, allowing for stoppages. By stereotyping the forms when ready for press, two impressions can be obtained at the same time from the machine, and thus an average of 33,000 or 36,000 copies per hour may be secured.

Printing machinery for *book-work*, as at present constituted, may be conveniently divided into two classes—*cylinder* and *flat-pressure* machines. Cylinder machines are again divisible into two varieties—one in which the sheet is held by means of tapes; the other by means of mechanical fingers, known as *grippers*. The first of these we have already noticed. The gripper principle

has been successfully applied to large two-cylinder perfecting machines, known as the *Anglo-French*, the cylinders of which are much smaller in diameter than in Applegath's, and placed almost close to each other. The grippers are fixed upon bars which extend across each of the cylinders, and are actuated by cams. The sheet, when laid on at the feeding board, is so placed that it projects slightly over the upper edge of the cylinder, whence it is seized by the grippers, which are made to open and close precisely at this point, and carried round to receive its first impression. After being printed on one side, on arriving at the point where the outer edges of the cylinders nearly meet, the sheet is released from the first and seized by the grippers of the second cylinder, by which means it is turned, and carried on to receive its second impression, and finally delivered perfect on the opposite side. By an ingenious adaptation of tapes, a slip-sheet is fed in between the blanket of the second cylinder and the first printed side of the paper, for the purpose of preventing 'set-off,' so that the very finest description of work may be executed. The inking arrangements are similar to those described in connection with Applegath's machine. From 800 to 1500 perfect impressions are obtained per hour from this machine.

Single-cylinder machines with the gripper motion are extensively used for job printing and small work. In these machines, which may be driven either by hand or steam power, the laying-on board is made with a peculiar motion, which causes it to be slightly elevated on each revolution of the cylinder; the sheet being laid on to guides at the inner edge of the table. This elevating motion is identical with a motion causing the cylinder to stand stationary and the grippers to open out for an instant, when they again close and revolve, taking away with them the white sheet, which is carried round to receive the impression, and taken off on the opposite side of the machine. Fig. 1, Plate 3, is an illustration of a jobbing machine of this class.

Flat-pressure Machines.—It is universally admitted that flat surface pressure is better calculated to produce good work than lineal pressure resulting from cylinders revolving over a form. For this reason, surface pressure or *platen* machines have been extensively employed for the finer descriptions of printing in preference to cylinder machines; although the improved machines of the latter class produce work, almost equal in quality, at a much greater speed. This superiority of the cylinder machine is partly accounted for by its superior inking arrangements, its mechanical construction admitting of a much more extended and perfect inking apparatus than in the ordinary *platen* machines. Recent improvements by Messrs. Napier, of London, however, have done much to surmount this defect, as well as to increase the productive powers of the machine, besides lessening the power required to work it. In general construction the *platen* machine may be said to partially resemble the ordinary hand-press, having a similar tympan and frisket. In the hands of different makers, it has assumed various modifications; sometimes it is made with a single end, but more generally works from two ends, when it is known as the *double-platen*. The main point in the mechanism is the endless screw or drum which takes the carriage and type from each end under the platen, and, after the impression is taken by means of a crank, returns it to its original position. The frisket, on which the sheet is laid, is attached to the tympan at the bottom, near its joints, so that, on the tympan being raised from the form after an impression, the printed sheet is left resting upon it, whence it is removed. These machines require the attendance of two boys at each end, and produce from 500 to 1000 impressions per hour.

COPPER PLATE PRINTING.

Under the article ENGRAVING we have already described the method by which copper and steel plates are engraved. The process of printing from them differs essentially from that adopted in letterpress work, being from *intaglio* instead of a raised surface.

As soon as the plate is finished by the engraver, it is ready for press. Having previously damped the paper to be printed, the workman places the plate upon a small stove, heated by gas or otherwise. When sufficiently heated to assist the ink in finding its way into the lines, he daubs over the whole surface of the plate with a thick oleaginous ink. The ink being well rubbed into the lines, he proceeds to clean the plate, by wiping off the ink from the surface, and finally polishing it with whiting, applied with the palm of the hand. When thoroughly cleaned, he lays the plate upon the flat table of a press, and places over it a sheet of the paper which is to receive the impression; he then winds the whole beneath a roller covered with blanketing, under a sharp pressure, by which the ink is forced from the hollow lines on to the paper, and thus produces the impression. This process of inking, &c., is repeated for each copy required.

The continued rubbing of the plate during the process of cleaning tends greatly to wear it, so much so, that few copper plates will yield more than a few thousand good impressions. Steel plates, however, are much more durable. [AQUATINTA ENGRAVING; LITHOGRAPHY; MEZZOTINT.]

There are various kinds of *Special Printing*, if we may be allowed the expression, to which, however, our limited space will not permit us to allude. Thus, Mr. Geo. Wallis has introduced *Autotypography*, in which drawings prepared in a peculiar manner are at once transferred to soft metal plates, and the artist's touches are reproduced in the most exact manner. Mr. Bradbury, by a series of careful experiments, perfected that most ingenious process known as *Nature-printing*, which is described in a separate article in this Encyclopædia. [NATURE-PRINTING.] Bank-note printing has its peculiarities; the present Bank of England note may be described as the joint production of Messrs. Smee, Hursman, and Coe, and was brought to perfection in 1854. Music printing from movable types, on account of its superior economy, has also come into very general use. Every day introduces some ingenious invention to the printer's notice, and either simplifies, expedites, cheapens, or perfects his work. [BLIND.]

(Among the principal works upon the invention and history of printing, are—Bern. à Malinkrot, *De Ortu et Progressu Artis Typographicæ*, 4to, Colon. Agrip., 1639; Fra. Pellegrino Antonio Orlandi, *Origine e Progressi della Stampa*, 4to, Bologna, 1722; Jo. Ch. Wolfii, *Monumenta Typographica*, 2 tom., 8vo, Hamb., 1740; Pros. Marchand, *Histoire de l'Origine et des Progrès de l'Imprimerie*, 4to, La Haye, 1740; Mich. Maittaire, *Annales Typographicæ*, 5 tom., 4to, Amstel. et Lon., 1719-1741; P. S. Fournier, *Dissertation sur l'Origine de l'Imprimerie*, 8vo, Paris, 1759; Jo. Dan. Schœpflini, *Vindiciæ Typographicæ*, 4to, Argentor., 1760; Singer's *Researches into the History of Playing Cards*; Ottley's *History of Engraving*; C. H. Timperley, *Encyclopædia of Typographical Anecdote*, London, 1842; and Jackson's *Treatise on Wood Engraving*, London, 1839.)

UC SOUTHERN REGIONAL LIBRARY FACILITY
A 000 081 386 5